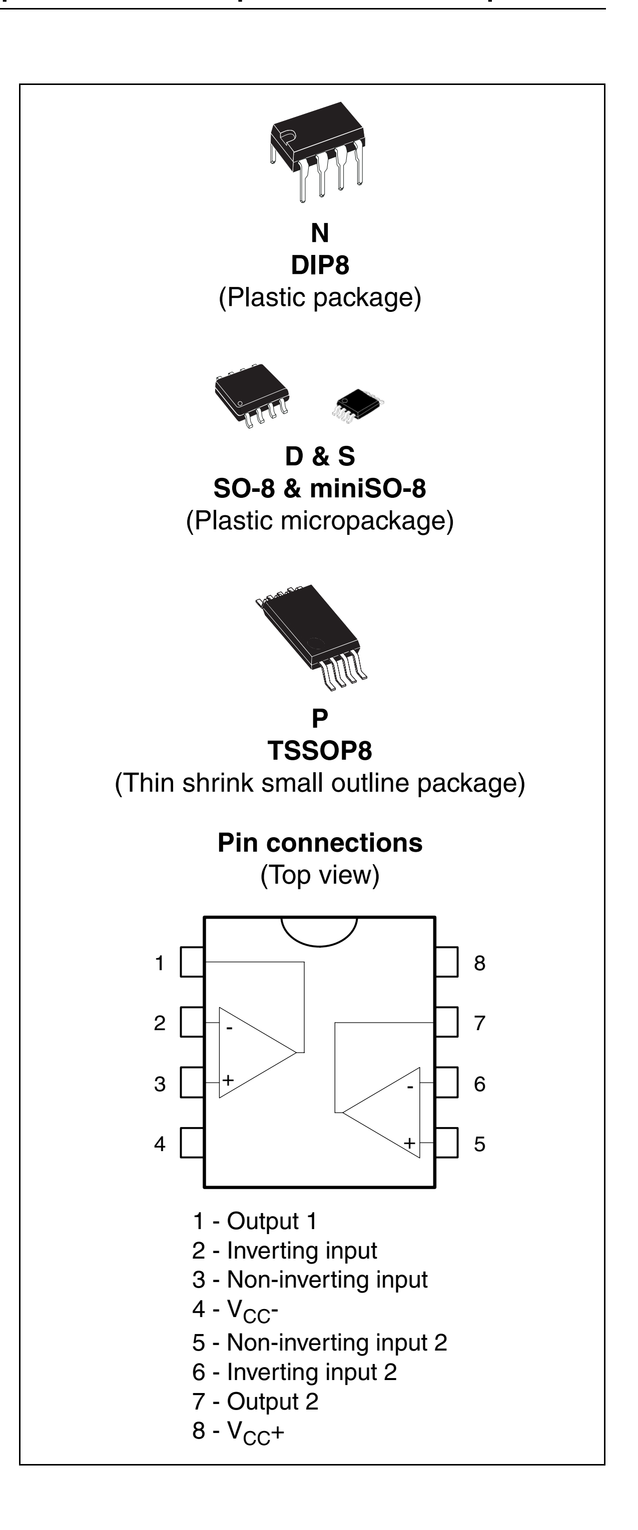


LM158-LM258-LM358

Low power dual operational amplifiers

Features

- Internally frequency-compensated
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1.1 MHz (temperature compensated)
- Very low supply current per operator essentially independent of supply voltage
- Low input bias current: 20 nA (temperature compensated)
- Low input offset voltage: 2 mV
- Low input offset current: 2 nA
- Input common-mode voltage range includes negative rails
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V to (V_{CC}^{+} - 1.5V)



Description

These circuits consist of two independent, high-gain, internally frequency-compensated op-amps, which are specifically designed to operate from a single power supply over a wide range of voltages. The low-power supply drain is independent of the magnitude of the power supply voltage.

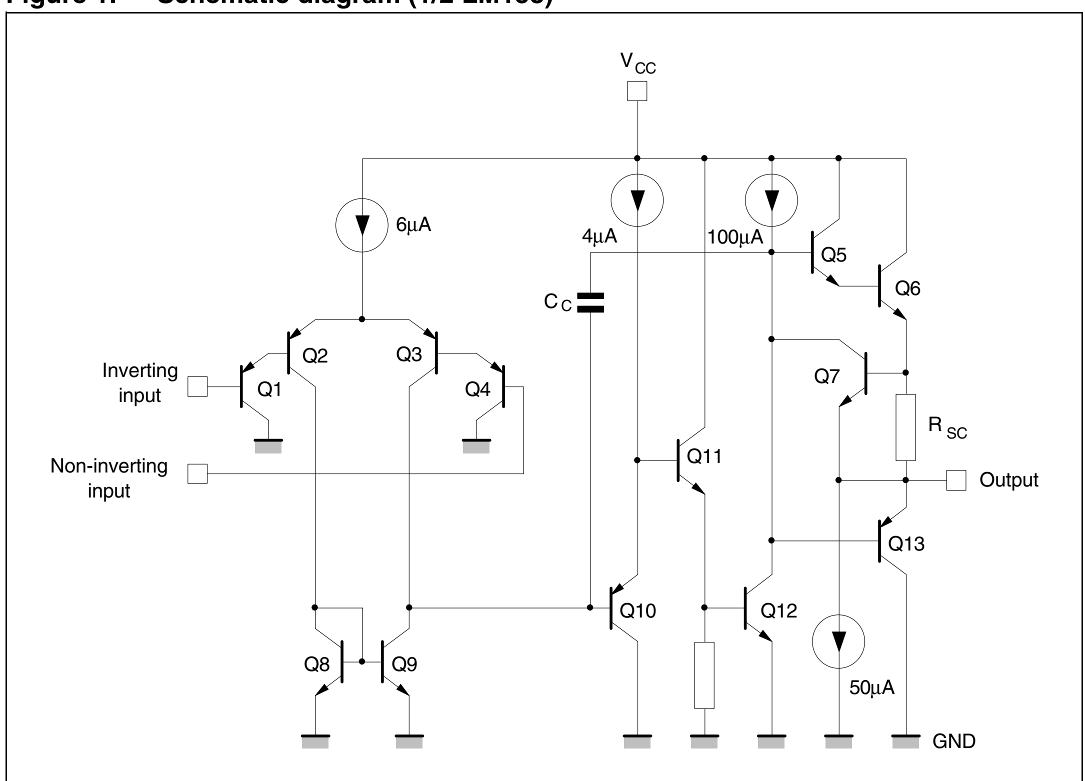
Application areas include transducer amplifiers, DC gain blocks and all the conventional op-amp circuits, which can now be more easily implemented in single power supply systems. For example, these circuits can be directly supplied with the standard +5 V, which is used in logic systems and will easily provide the required interface electronics with no additional power supply.

In linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

1 Schematic diagram



Figure 1. Schematic diagram (1/2 LM158)



2 Absolute maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	LM158,A	LM258,A	LM358,A	Unit
V_{CC}	Supply voltage	+/-16 or 32			V
V_i	Input voltage	32			V
V_{id}	Differential input voltage	32			V
	Output short-circuit duration (1)	Infinite			
I_{in}	Input current (2)	5 mA in DC or 50 mA in AC (duty cycle = 10%, T=1s)			mA
T_{oper}	Operating free-air temperature range	-55 to +125	-40 to +105	0 to +70	°C
T_{stg}	Storage temperature range	-65 to +150			°C
T_j	Maximum junction temperature	150			°C
R_{thja}	Thermal resistance junction to ambient(3) SO-8 MiniSO-8 TSSOP8 DIP8	 125 190 120 85			°C/W
R_{thjc}	Thermal resistance junction to case (3) SO-8 MiniSO-8 TSSOP8 DIP8	 40 39 37 41			°C/W
ESD	HBM: human body model(4)	300			V
	MM: machine model(5)	200			V
	CDM: charged device model(6)	1.5			kV

1. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15 V. The maximum output current is approximately 40 mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short circuits on all amplifiers.
2. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward-biased and thereby acting as input diode clamp. In addition to this diode action, there is NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the Op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time during which an input is driven negative.
This is not destructive and normal output is restored for input voltages above -0.3 V.
3. Short-circuits can cause excessive heating and destructive dissipation. R_{th} are typical values.
4. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
5. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
6. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

3 Operating conditions

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	3 to 30	V
V_{icm}	Common mode input voltage range(1)	V_{CC}^- -0.3 to V_{CC}^+ -1.5	V
T_{oper}	Operating free air temperature range LM158 LM258 LM358	 -55 to +125 -40 to +105 0 to +70	°C

1. When used in comparator, the functionality is guaranteed as long as at least one input remains within the operating common mode voltage range.

4 Electrical characteristics

Table 3. Electrical characteristics for V_{CC}^+ = +5 V, V_{CC}^- = Ground, V_o = 1.4 V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage [1] LM158A LM258A, LM358A LM158, LM258 LM358		 1 2	 2 3 5 7	mV
	$T_{min} \le T_{amb} \le T_{max}$ LM158A, LM258A, LM358A LM158, LM258 LM358			 4 7 9	
DV_{io}	Input offset voltage drift LM158A, LM258A, LM358A LM158, LM258, LM358		 7 7	 15 30	µV/°C
I_{io}	Input offset current LM158A, LM258A, LM358A LM158, LM258, LM358 $T_{min} \le T_{amb} \le T_{max}$ LM158A, LM258A, LM358A LM158, LM258, LM358		 2 2	 10 30 30 40	nA
DI_{io}	Input offset current drift LM158A, LM258A, LM358A LM158, LM258, LM358		 10 10	 200 300	pA/°C
I_{ib}	Input bias current [2] LM158A, LM258A, LM358A LM158, LM258, LM358 $T_{min} \le T_{amb} \le T_{max}$ LM158A, LM258A, LM358A LM158, LM258, LM358		 20 20	 50 150 100 200	nA
A_{vd}	Large signal voltage gain V_{CC}^+= +15 V, R_L = 2 kΩ, V_o = 1.4 V to 11.4 V $T_{min} \le T_{amb} \le T_{max}$	 50 25	 100		V/mV
SVR	Supply voltage rejection ratio V_{CC}^+ = 5 V to 30 V, $R_s \le$ 10 kΩ $T_{min} \le T_{amb} \le T_{max}$	 65 65	 100		dB
I_{CC}	Supply current, all amp, no load $T_{min} \le T_{amb} \le T_{max}$ V_{CC}^+ = +5 V $T_{min} \le T_{amb} \le T_{max}$ V_{CC}^+ = +30 V		 0.7	 1.2 2	mA
V_{icm}	Input common mode voltage range V_{CC}^+= +30 V [3] $T_{min} \le T_{amb} \le T_{max}$	 0 0		 V_{CC}^+ -1.5 V_{CC}^+ -2	V

Table 3. Electrical characteristics for V_{CC}^+ = +5 V, V_{CC}^- = Ground, V_o = 1.4 V, T_{amb} = +25°C (unless otherwise specified) (continued)

Symbol	Parameter	Min.	Typ.	Max.	Unit
CMR	Common mode rejection ratio $R_s \leq 10$ kΩ $T_{min} \leq T_{amb} \leq T_{max}$	70 60	85		dB
I_{source}	Output current source V_{CC}^+ = +15 V, V_o = +2 V, V_{id} = +1 V	20	40	60	mA
I_{sink}	Output sink current V_{CC}^+ = +15 V, V_o = +2 V, V_{id} = -1 V V_{CC}^+ = +15 V, V_o = +0.2 V, V_{id} = -1 V	10 12	20 50		mA µA
V_{OH}	High level output voltage R_L = 2 kΩ, V_{CC}^+ = 30 V $T_{min} \leq T_{amb} \leq T_{max}$ R_L = 10 kΩ, V_{CC}^+ = 30 V $T_{min} \leq T_{amb} \leq T_{max}$	26 26 27 27	27 28		V
V_{OL}	Low level output voltage R_L = 10 kΩ $T_{min} \leq T_{amb} \leq T_{max}$		5	20 20	mV
SR	Slew rate V_{CC}^+ = 15 V, V_i = 0.5 to 3 V, R_L = 2 kΩ, C_L = 100 pF, unity gain	0.3	0.6		V/µs
GBP	Gain bandwidth product V_{CC}^+ = 30 V, f = 100 kHz, V_{in} = 10 mV, R_L = 2 kΩ, C_L = 100 pF	0.7	1.1		MHz
THD	Total harmonic distortion f = 1 kHz, A_v = 20 dB, R_L = 2 kΩ, V_o = 2 V_{pp}, C_L = 100 pF, V_O = 2 V_{pp}		0.02		%
e_n	Equivalent input noise voltage f = 1 kHz, R_s = 100 Ω, V_{CC}^+ = 30 V		55		$\frac{nV}{\sqrt{Hz}}$
V_{o1}/V_{o2}	Channel separation[4] 1 kHz ≤ f ≤ 20 kHz		120		dB

1. V_o = 1.4 V, R_s = 0 Ω, 5 V < V_{CC}^+ < 30 V, 0 < V_{ic} < V_{CC}^+ - 1.5 V
2. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so there is no change in the load on the input lines.
3. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC}^+ - 1.5 V, but either or both inputs can go to +32 V without damage.
4. Due to the proximity of external components, ensure that stray capacitance between these external parts does not cause coupling. Typically, this can be detected because this type of capacitance increases at higher frequencies.

Figure 2. Open loop frequency response

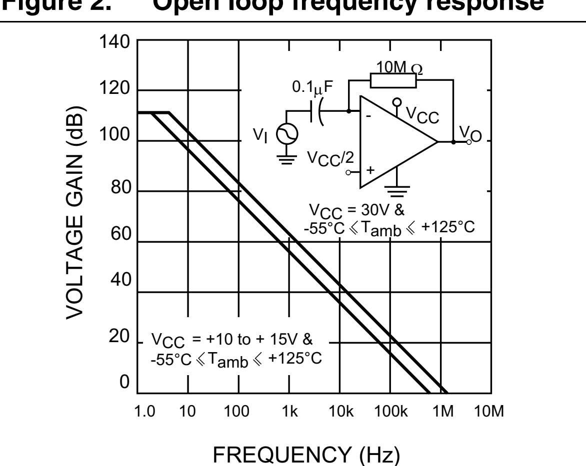


Figure 3. Large signal frequency response

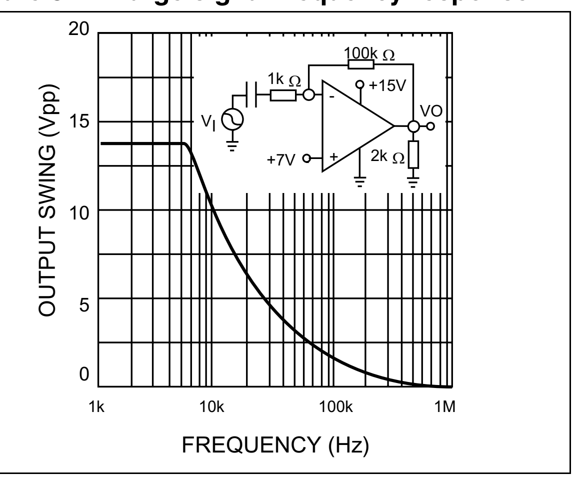


Figure 4. Voltage follower pulse response

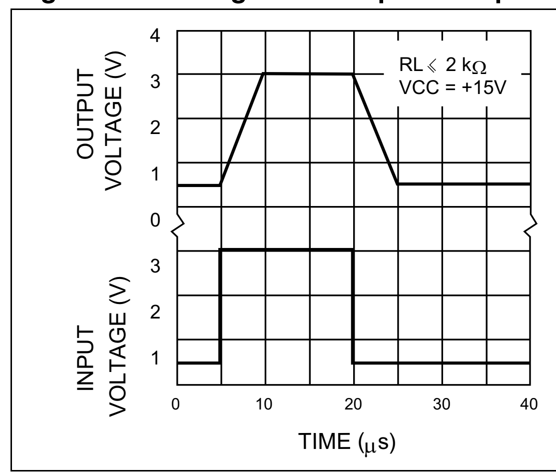


Figure 5. Voltage follower pulse response

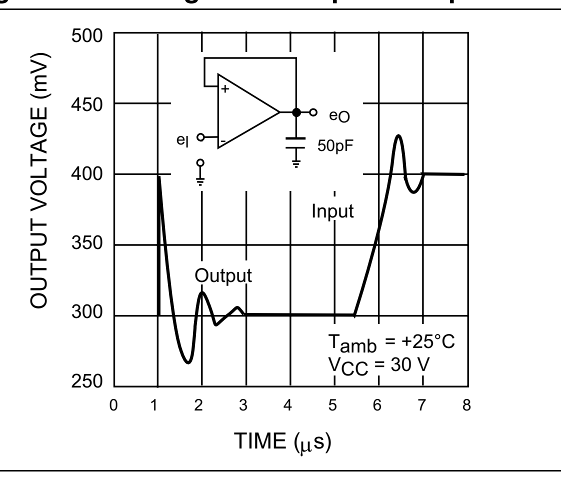


Figure 6. Input current

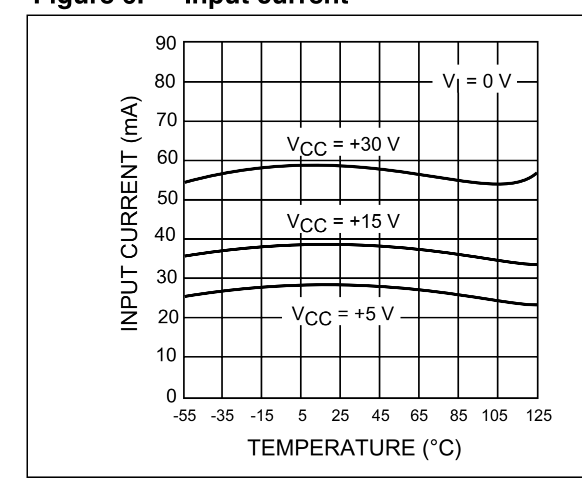


Figure 7. Output characteristics

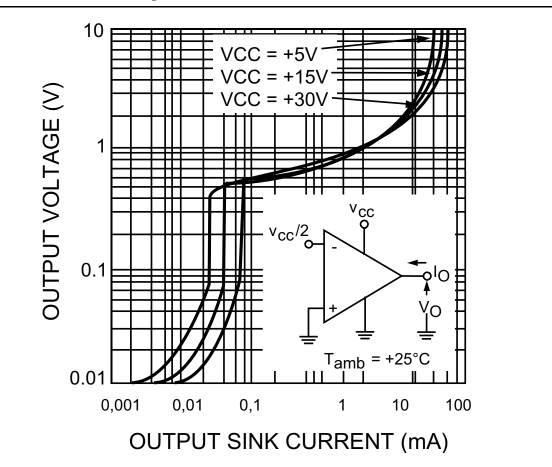


Figure 8. Output characteristics

OUTPUT VOLTAGE REFERENCED TO V_{CC}^{+} (V)
8 7 6 5 4 3 2 1
0,001 0,01 0,1 1 10 100
OUTPUT SOURCE CURRENT (mA)
V_{CC}
$V_{CC}/2$
V_O
I_O
Independent of V_{CC}
T_{amb} = +25°C

Figure 9. Current limiting

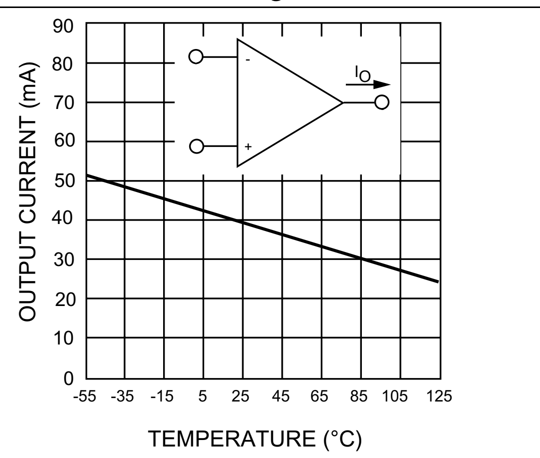


Figure 10. Input voltage range

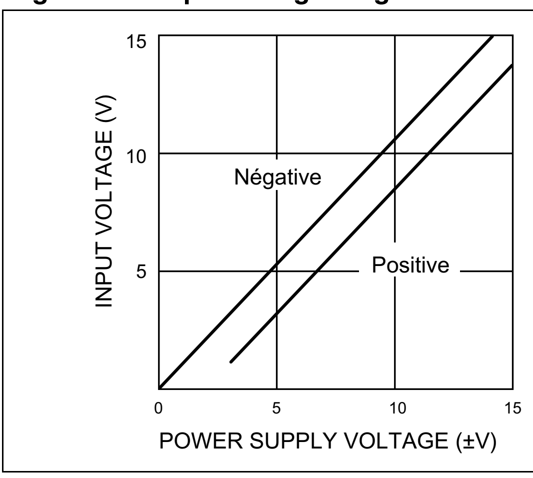


Figure 11. Open loop gain

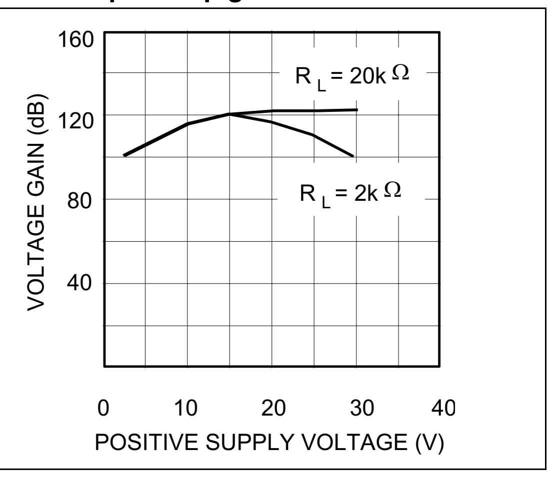


Figure 12. Supply current

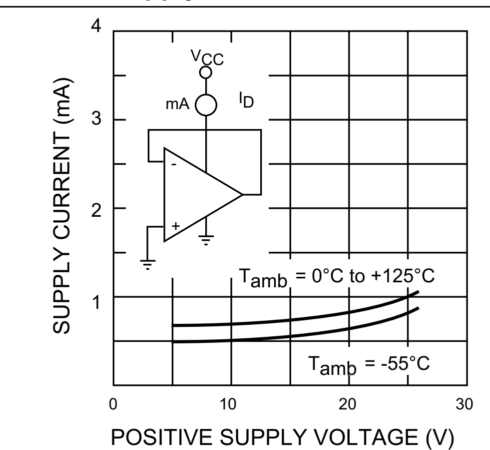


Figure 13. Input current

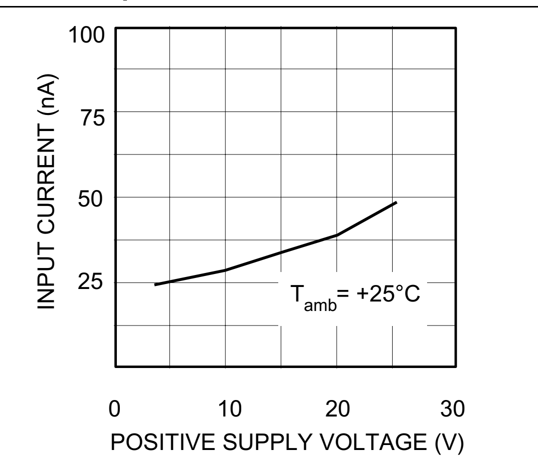


Figure 14. Gain bandwidth product

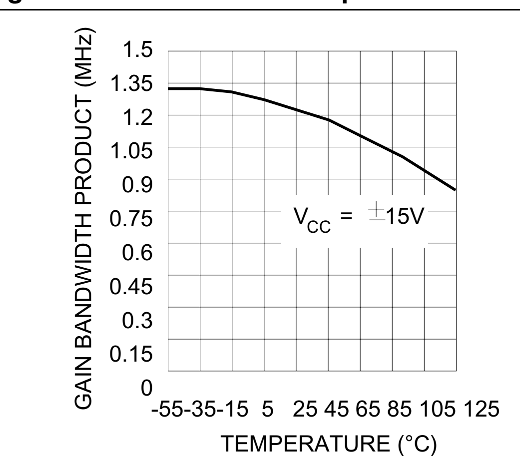


Figure 15. Power supply rejection ratio

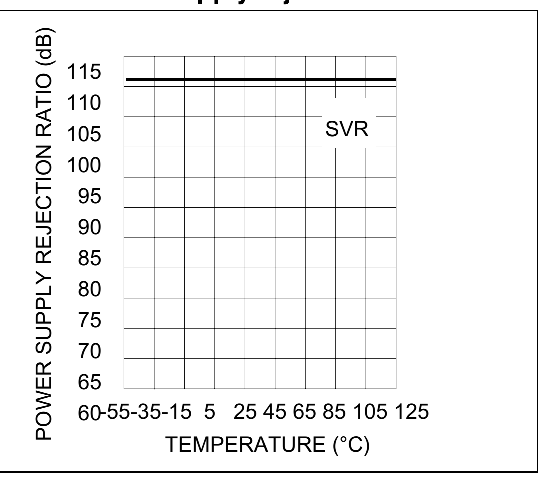


Figure 16. Common mode rejection ratio

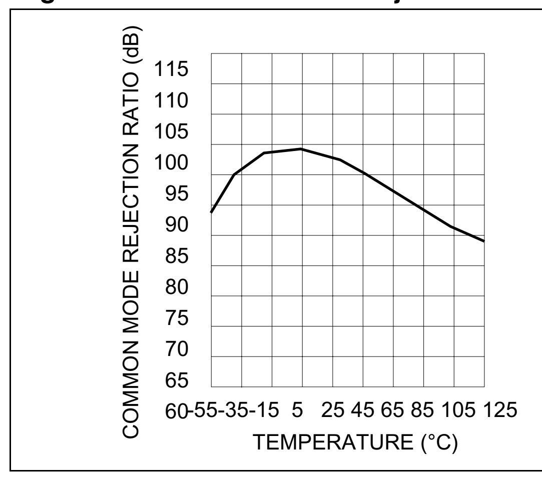
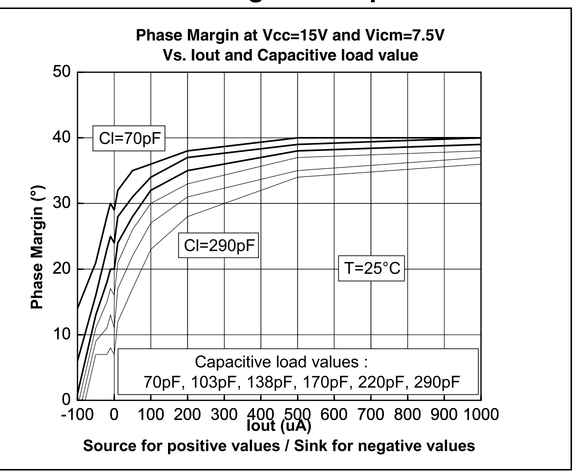


Figure 17. Phase margin vs. capacitive load



5 Typical applications

Single supply voltage V_{CC} = +5 V_{DC}.

Figure 18. AC-coupled inverting amplifier

Figure 19. Non-inverting DC amplifier

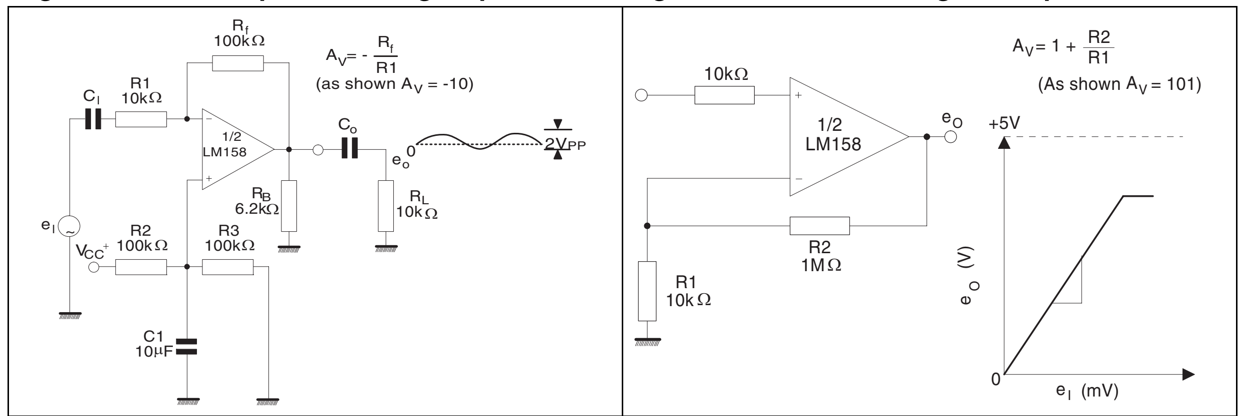


Figure 20. AC-coupled non-inverting amplifier

Figure 21. DC summing amplifier

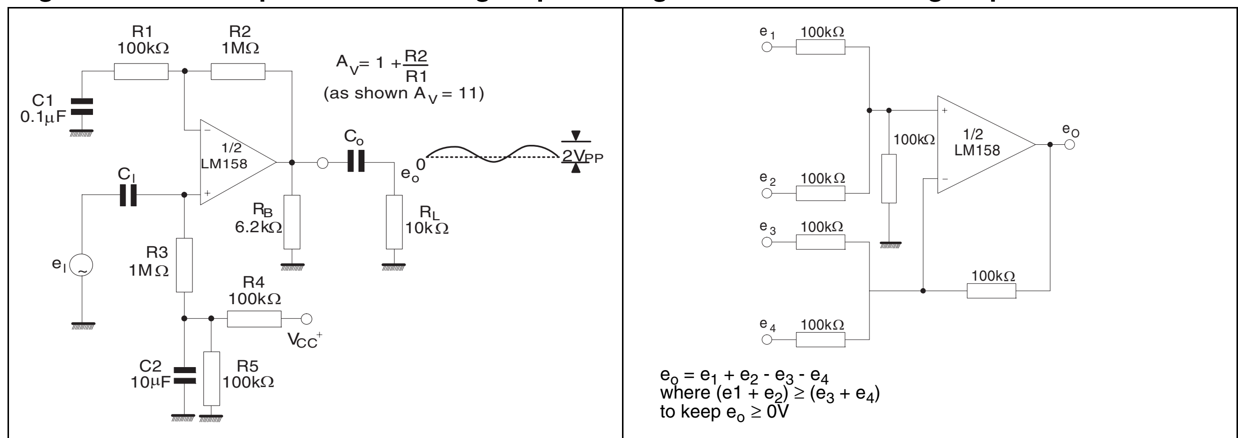


Figure 22. High input Z, DC differential amplifier

Figure 23. High input Z adjustable gain DC instrumentation amplifier

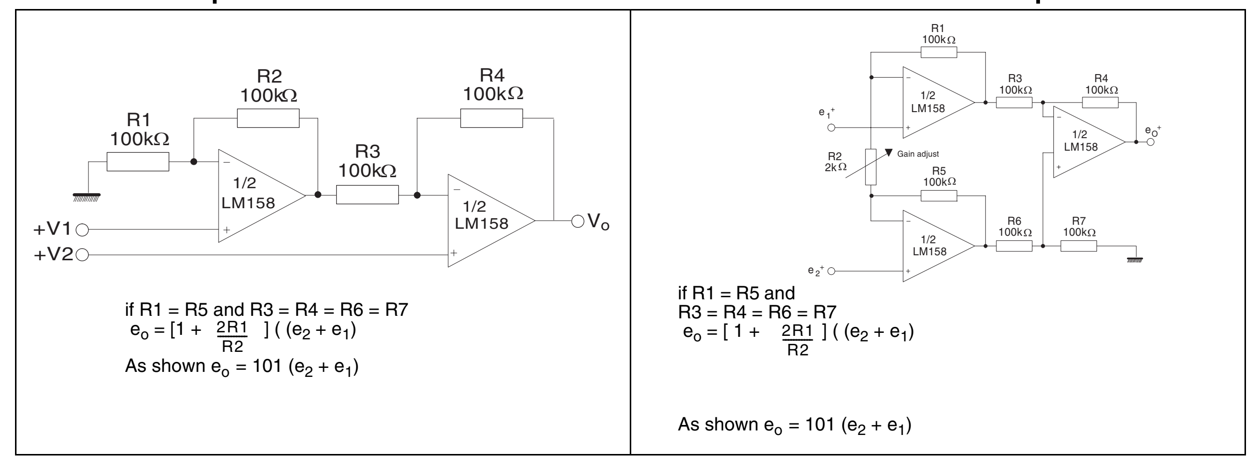


Figure 24. Using symmetrical amplifiers to reduce input current

Figure 25. Low drift peak detector

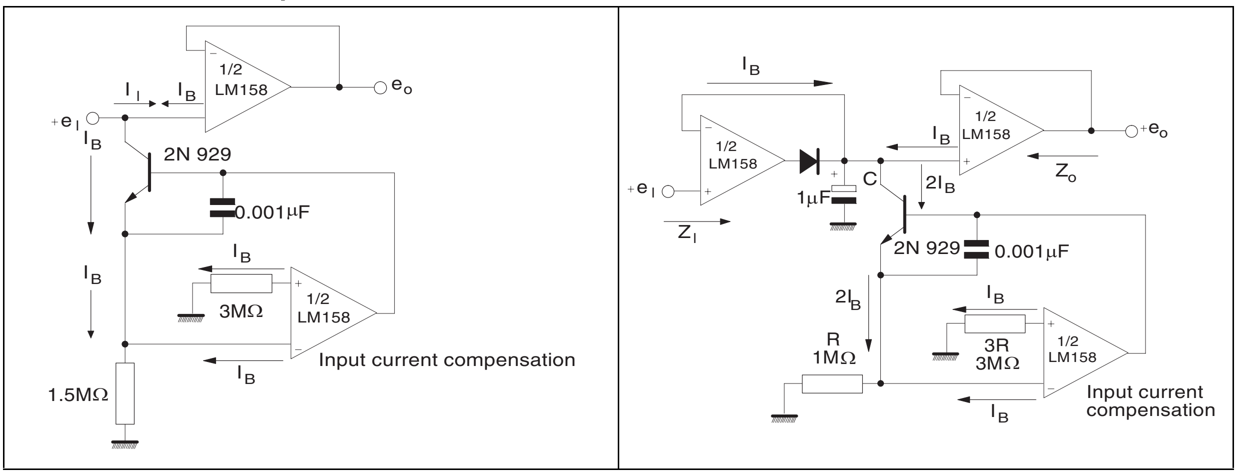
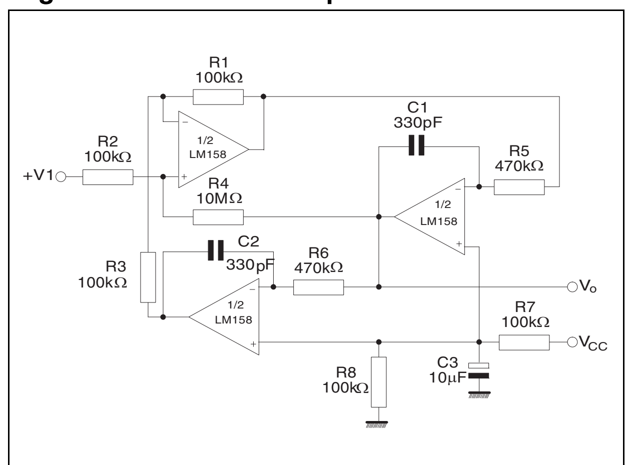


Figure 26. Active band-pass filter



6 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

6.1 DIP8 package information

Figure 27. DIP8 package mechanical drawing

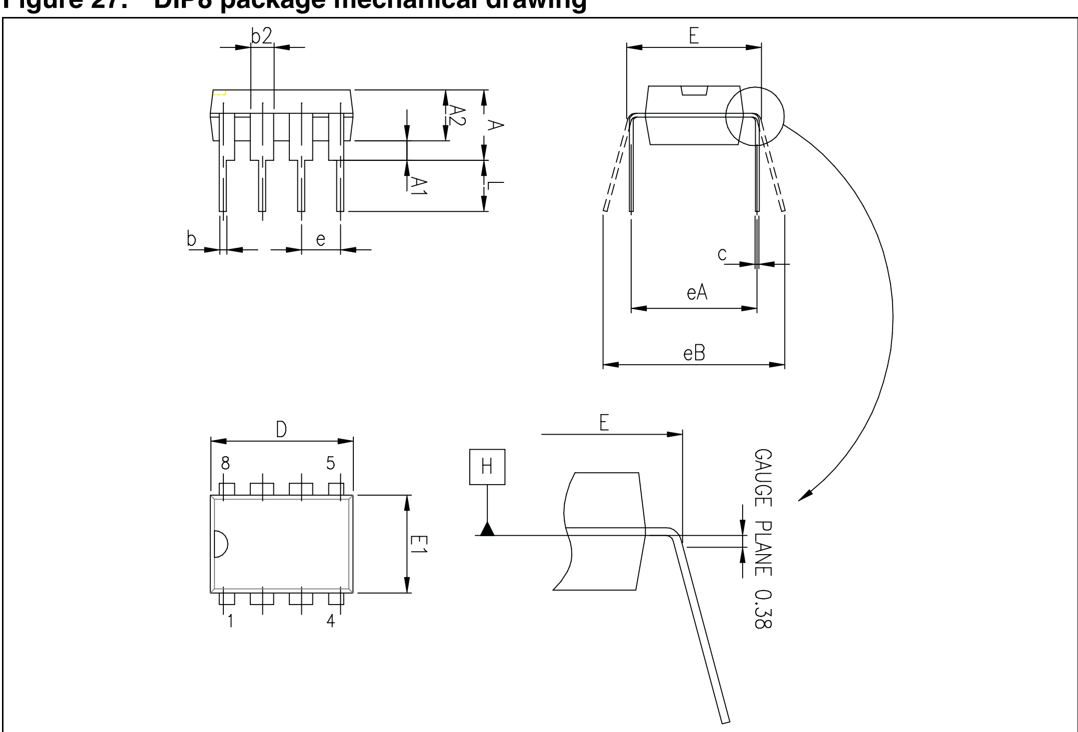


Table 4. DIP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150

6.2 SO-8 package information

Figure 28. SO-8 package mechanical drawing

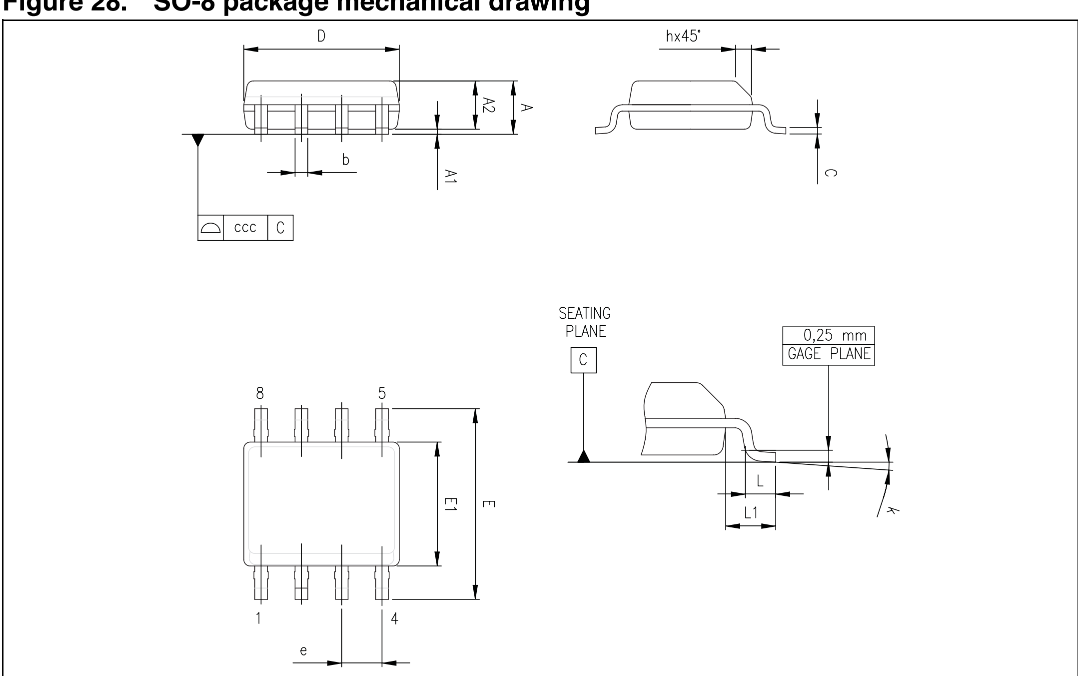


Table 5. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

6.3 MiniSO-8 package information

Figure 29. MiniSO-8 package mechanical drawing

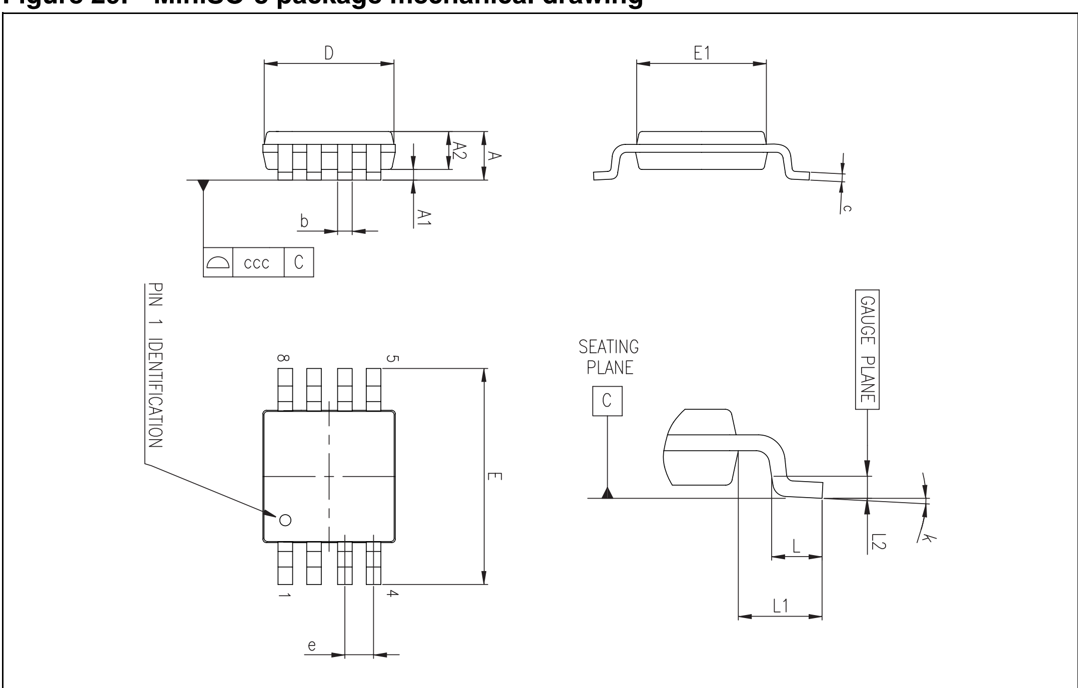


Table 6. MiniSO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

6.4 TSSOP8 package information

Figure 30. TSSOP8 package mechanical drawing

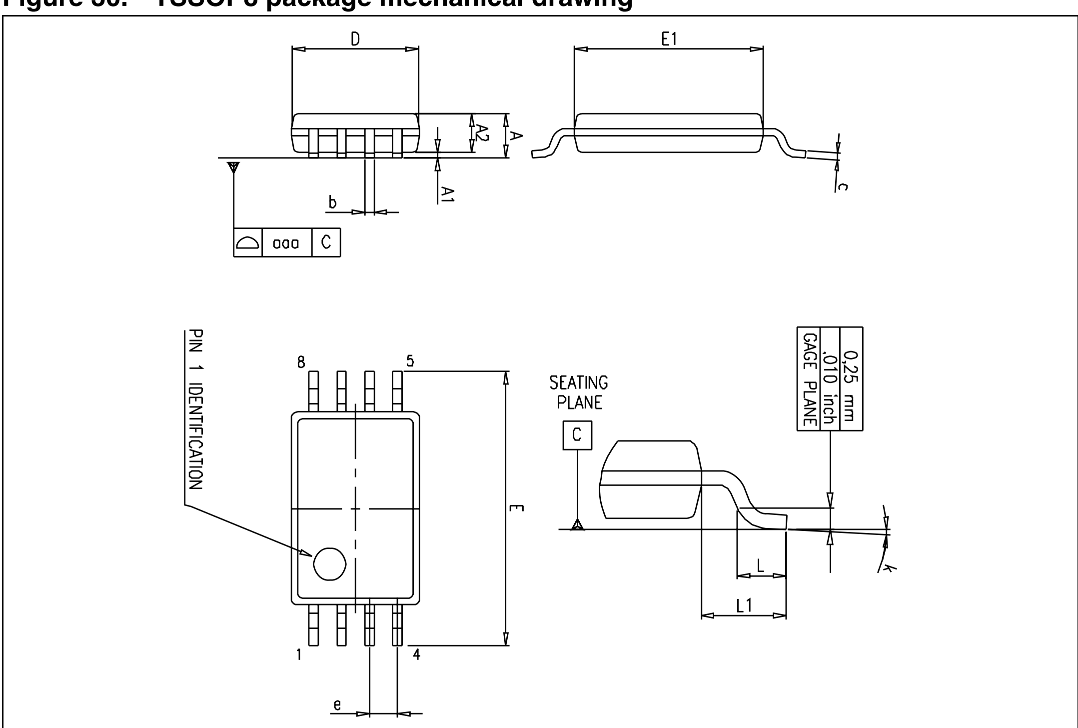


Table 7. TSSOP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa		0.1			0.004	

7 Ordering information

Table 8. Order codes

Order code	Temperature range	Package	Packaging	Marking
LM158N	-55°C, +125°C	DIP8	Tube	LM158N
LM158D LM158DT		SO-8	Tube or tape & reel	158
LM158YD[1] LM158YDT[1]		SO-8 Automotive grade		158Y
LM258AN LM258N	-40°C, +105°C	DIP8	Tube	LM258A LM258N
LM258AD LM258ADT		SO-8	Tube or tape & reel	258A
LM258AYD[1] LM258AYDT[1]		SO-8 Automotive grade		258AY
LM258D LM258DT		SO-8	Tube or tape & reel	258
LM258YD[1] LM258YDT[1]		SO-8 Automotive grade		258Y
LM258PT LM258APT		TSSOP8	Tape & reel	258 258A
LM258YPT[2] LM258AYPT[2]		TSSOP8 Automotive grade		258Y 258AY
LM258AST LM258ST		MiniSO-8	Tape & reel	K408 K416
LM358N LM358AN	0°C, +70°C	DIP8	Tube	LM358N LM358AN
LM358D LM358DT		SO-8	Tube or tape & reel	358
LM358YD[1] LM358YDT[1]		SO-8 Automotive grade		358Y
LM358AD LM358ADT		SO-8		358A
LM358PT LM358APT		TSSOP8	Tape & reel	358 358A
LM358YPT[2] LM358AYPT[2]		TSSOP8 Automotive grade		358Y 358AY
LM358ST LM358AST		MiniSO-8	Tape & reel	K405 K404

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.
2. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

8 Revision history

Table 9. Document revision history

Date	Revision	Changes
01-Jul- 2003	1	First release.
02-Jan-2005	2	R_{thja} and T_j parameters added in AMR *Table 1 on page 3*.
01-Jul-2005	3	ESD protection inserted in *Table 1 on page 3*.
05-Oct-2006	4	Added *Figure 17: Phase margin vs. capacitive load*.
30-Nov-2006	5	Added missing ordering information.
25-Apr-2007	6	Removed LM158A, LM258A and LM358A from document title. Corrected error in MiniSO-8 package data. L1 is 0.004 inch. Added automotive grade order codes in *Section 7 on page 17*.
12-Feb-2008	7	Corrected V_{CC} max (30 V instead of 32 V) in operating conditions. Changed presentation of electrical characteristics table. Deleted V_{opp} parameter in electrical characteristics table. Corrected miniSO-8 package information. Corrected temperature range for automotive grade order codes. Updated automotive grade footnotes in order codes table.
26-Aug-2008	8	Added limitations on input current in *Table 1: Absolute maximum ratings*. Corrected title for *Figure 11*. Added E and L1 parameters in *Table 5: SO-8 package mechanical data*. Changed *Figure 30*.

